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№ 193

Scientific Intelligence Report

The United Arab Republic Ballistic Missile and Space Programs

OSI-SR/65-29
2 August 1965

DIRECTORATE OF SCIENCE AND TECHNOLOGY

Office of Scientific Intelligence

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Scientific Intelligence Report

THE UNITED ARAB REPUBLIC BALLISTIC MISSILE AND SPACE PROGRAMS

Project Officer

[redacted] 25X1

OSI–SR/65–29

2 August 1965

CENTRAL INTELLIGENCE AGENCY

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PREFACE

The existence of a United Arab Republic (UAR) program for the development of surface-to-surface ballistic missiles, utilizing [redacted] technicians, has been well publicized for some time. This report summarizes UAR missile and space developments, except Soviet missile aid, which to date has been limited to short-range tactical and defensive systems. Both open source and classified information available by 27 July 1965 has been used. Throughout this paper the terms United Arab Republic and Egypt are used interchangeably.

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APPENDICES

FIGURES

THE UNITED ARAB REPUBLIC BALLISTIC MISSILE AND SPACE PROGRAMS

PROBLEM

To assess the ballistic missile and space programs of the United Arab Republic.

SUMMARY AND CONCLUSIONS

1. The UAR, assisted by some 75 to 80 West German technicians, is developing two surface-to-surface missiles—the Victor and the Conqueror. The Victor, which is based on the French Veronique sounding rocket, appears capable of delivering a 500-pound payload to a range of approximately 175 nautical miles. The larger Conqueror missile is probably capable of delivering as much as 2,000 pounds to about 200 nautical miles.

2. The military effectiveness of these missiles has been hindered by UAR inability to develop effective and reliable guidance components, particularly gyros. Accuracies obtained thus far would indicate a CEP (circular error probable) in the neighborhood of 3 to 5 nautical miles. The Egyptians are attemping to develop an all-inertial guidance system with a CEP of less than two nautical miles, but admit that such a system could not be operational before 1967. Recent flight tests, apparently involving this new system, revealed the presence of serious vibrations in the missiles. There is no information as to the cause of these vibrations, but they became so violent at the speed of sound that the guidance systems failed, causing the missiles to go out of control. Because of this problem, flight testing has been temporarily suspended.

3. Both UAR missiles presently use a nitric acid/turpentine propellant combination. Plans apparently are underway to use hydrazine as the fuel in place of turpentine. This change would boost range and payload-carrying capacity of the missiles about ten percent. (Performance estimates in this report are based on the turpentine combination figures.)

4. The program has been plagued by technical, personnel, and financial difficulties almost since it began in 1960. The Egyptians, however, undoubtedly are aware of [redacted] and seem as determined as ever to continue development of their own systems.

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5. It will probably be at least 1967 before the Egyptians solve all of the missile reliability, fabrication, and guidance problems and can begin serious production and deployment. In the meantime, activity will continue to be limited to the fabrication of prototypes for use in a flight test program.

6. The UAR has combined the Victor and the Conqueror missiles into a two-stage vehicle called the Pioneer. The Pioneer reportedly comprises two stages of a planned three-stage satellite-launching vehicle with which the German-UAR team hopes to orbit a small satellite. However, calculations based on the estimated performance of this and other hardware combinations available to the Egyptians indicate that the maximum velocity attainable by any UAR satellite launch vehicle falls at least 5,000 feet per second (fps) short of the minimum required orbital velocity of 25,000 fps. In addition, it is questionable whether the current Egyptian guidance system, which has been used solely in an SSM role thus far, is capable of this satellite injection role. Thus, there is little prospect that the Egyptians will successfully launch a satellite in the near future.

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in the unlikely event that the Germans do leave, the Arab engineers and technicians would find it difficult to continue the program alone and probably would seek other outside assistance.

DISCUSSION

EARLY UAR ROCKETRY ACTIVITIES

The UAR has shown an intense interest in acquiring guided missiles since World War II and has approached most of the missile-producing nations of the world on this matter at one time or another. These approaches have included offers of outright purchase, licensed manufacture in Egypt, and the recruitment of Western European technicians to develop rockets of relatively unique design. Figure 1 summarizes the major milestones leading toward a United Arab Republic missile capability.

On 23 July 1962, in connection with the week-long celebration of the 10th anniversary of the Egyptian revolution, the UAR displayed rockets of two different sizes as evidence of the country's scientific and technological achievement. Ten of each rocket, the larger called Al Qahir (The Conqueror), and the smaller, called Al Zafir (The Victor), were paraded through the streets of Cairo. Two days before the parade, two of each type were launched from a desert range.[1]

One year later, in the July 1963 parade, the Egyptians again displayed their Conqueror and Victor missiles (now guided); this time only six of each. They also unveiled a new item; four prototypes of a two-stage combination called Al Ra'id (The Pioneer). This was the first public showing of the Pioneer, which proved to be a mating of a Conqueror, for the first stage, and an adapted Victor for the second. The parades in July 1964 and July 1965 were essentially repeats of the 1963 parade.

Development Under German Scientists

The UAR missiles displayed in the Cairo parades are the result of a development program which began in early 1960 when the Egyptians approached the internationally [redacted] 25X6

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Very little information is available as to the progress made in the following year, but on 21 July 1962, two days before the 10th anniversary parade, representatives of the press were invited to witness from a distance the firing of four rockets (two Victors and two Conquerors) at a site in the desert northwest of Cairo. From this and several other pieces of evidence—8 unsuccessful firings reported by [redacted] reported sightings, and the 20 missiles and rockets displayed in the parade—about 15 rockets of each of the two sizes appear to have been assembled up to July 1962.

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Purchase of US Sounding Rockets

Probably to gain experience with proven hardware, the Egyptians, in October 1961, purchased six Rocmiz IV sounding rockets from the Zimney Corporation of Monrovia, California. Four of the six rockets were shipped, and reportedly were intended for use in UAR high-altitude mass spectrography experiments. A launching was scheduled for December 1961 but was postponed until 4 February 1962 in order that the service of a US engineer could be obtained. The location of this launch was to be 16 nautical miles southwest of Cairo on the road to Fayyum, probably at the site of the old Dashur artillery range, which has since been converted into a surface-to-air missile training center. Bad weather interfered with the 4 February firing schedule, and the US engineer departed prior to any actual firings. The Egyptians attempted to have the US engineer return again in March or April 1962 to assist in the test but were unsuccessful.

Apparently, none of these four rockets have been fired, and by now they probably have deteriorated to a point of little use. Because of the marginal military significance of these rockets, the US State Department decreed that the remaining two rockets (still stored in the US), could not be shipped until it had been shown proof of firing of the first four, even though all six had been paid for. Costing Egypt approximately $25,000 each, these rockets were theoretically capable of carrying their 50-pound sodium payloads to an altitude of 165 miles. (See figure 3.)[3 4]

THE UAR MISSILES

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The Victor (Al Zafir)

Showing [redacted] influence, the UAR Victor is a close copy of the single-stage liquid-fueled Veronique, the sounding rocket which he had designed just two years previously for France. The Victor [redacted] just over 20 feet long, and utilizes nitric acid as its oxidizer and turpentine as its fuel. There are indications that the Egyptians are attempting

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Figure 3

US ROCMIZ IV SOUNDING ROCKET (JAVELIN/VIPER), 1961

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to change to a nitric acid/hydrazine combination to improve performance. Using the I_{sp} and specific density of the turpentine mixture, it is estimated that the Victor, in an SSM role, is capable of delivering a 500-pound payload a distance of 175 nautical miles, with a CEP of 5 nautical miles. Gross weight at lift-off is about 3,300 pounds, with a sea level thrust of about 9,000 pounds, both again very similar to the Veronique. (See figures 4 and 8.)

The Conqueror (Al Qahir)

The Conqueror, which apparently was developed concurrently with the Victor, is somewhat larger, [redacted] It probably carries about 12,400 pounds of nitric acid and turpentine (also possibly being changed to nitric acid and hydrazine), and produces a thrust of about 44,000 pounds. Its high lift-off weight (estimated to be about 18,400 pounds) is somewhat inefficient by modern standards, and seemingly reflects either the state of the art among itinerant missile designers or the hazards of semi-clandestine component procurement. Nonetheless, the Conqueror, as an SSM, could probably deliver up to 2,000 pounds a distance of about 200 nautical miles. (See figures 5, 6, and 8.)

The Pioneer (Al Ra'id)

The Pioneer is a two-stage, liquid-fueled missile consisting of a Conqueror as the first stage with an adapted Victor as the second.[5] It was first shown in the July 1963 parade. Reportedly designed as a high-altitude sounding rocket, the Egyptians are now touting it as part of a planned satellite launch vehicle and also as a surface-to-surface missile. Overall, the Pioneer is almost 43 feet long, has a lift-off weight of over 19,000 pounds, and produces a total thrust of 53,000 pounds. In an SSM mode, it could probably carry a payload of about 500 pounds a distance of 800 nautical miles. It could, as the Egyptians have stated, also comprise two stages of a planned three-stage satellite launch vehicle.[6 7] (See figures 7 and 8.)

PRESENT MISSILE AND SPACE RESEARCH AND DEVELOPMENT

The UAR missile and space programs, controlled by a joint UAR Armed Services Committee headed by Air Chief Marshal Muhammad Sidqi Mahmud, are personally directed by Brigadier Isam al-Din Mahmud Khalil. Khalil, former Director of Intelligence for the UAR Air Force, is responsible directly to UAR President Nasir for the missile, space, and the jet aircraft programs. The missile and space research programs are centered in Heliopolis, a suburb of Cairo, and consist of a "military" division and a "civilian" division.[8 9]

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Military Conversion Program

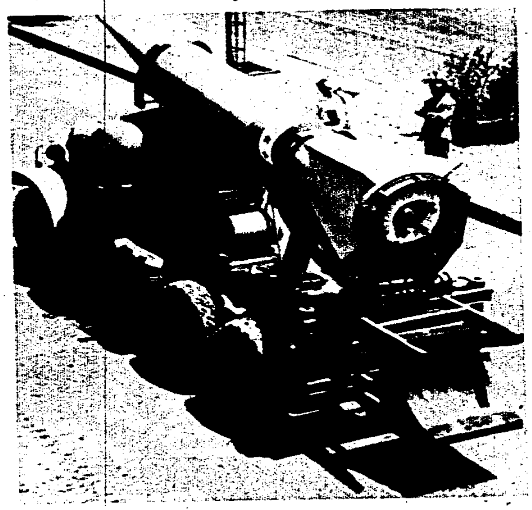
What apparently began as a sounding rocket program has very obviously become a military surface-to-surface missile development program. The Military Division in Heliopolis is concentrating on improving and converting the Victor and Conqueror vehicles into reliable guided missile systems. Reporting in this area is limited, but there are indications that slow progress is being made.

The Victor, when first displayed in the July 1962 parade, lacked any control surfaces and appeared to be unguided. The ten shown were transported rather simply on standard commercial vehicles of both Soviet and West German origin. By the July 1963 parade, however, several improvements had been made. Four jet vanes were evident at the rear of the rocket motor indicating that some sort of control system had been added. Also, two of the six Victors displayed were mounted on mobile erector-launchers, constructed on Soviet ZIL 157V truck chassis. (See figure 4.)

The Conqueror, also, has undergone several changes. Photographs of the Conquerors being fired on 21 July 1962 show them to have rather large fins, such as would be required to stabilize an unguided rocket. (See figure 6.) However, the Conquerors displayed in the parade that same month had comparatively small fins (as do those in later parades), as well as four jet vanes evident in the rocket nozzle, similar to those utilized in the Ger-

Figure 4

UAR VICTOR (AL ZAFIR) MISSILE



UAR VICTOR ON A MOBILE LAUNCHER, 23 JULY 1963

CHARACTERISTICS

Thrust (sea level)	9,000 lbs.
Weight (gross)	3,310 lbs.
" (payload)	500 lbs.
" (structure)	710 lbs.
" (propellant)	2,100 lbs.
Propellant	Nitric acid/turpentine
Isp	231 sec.
Mass Ratio	2.74
Time to burn-out	50 sec.
Velocity at burn-out	5,890 fps.
Range	175 n.m.
C.E.P.	3-5 n.m.

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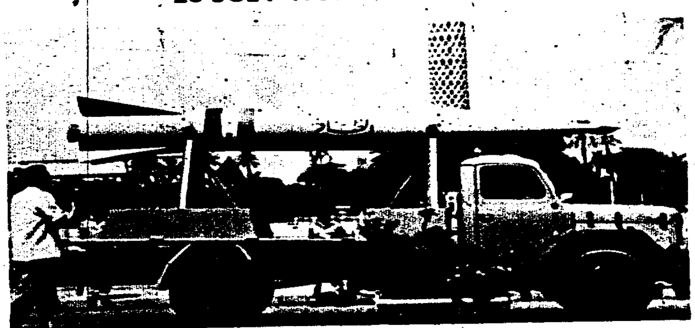
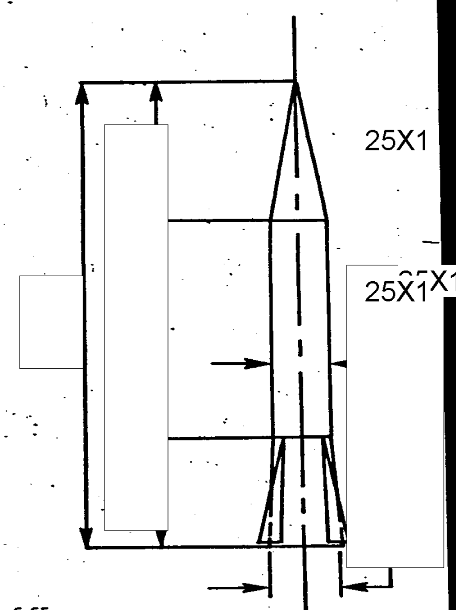


JULY 1962



JULY 1964

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Figure 5

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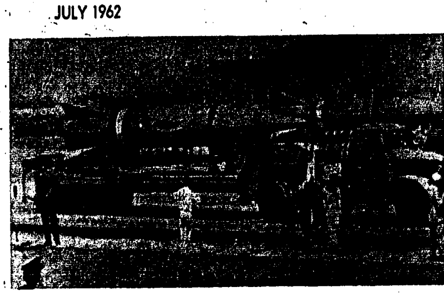
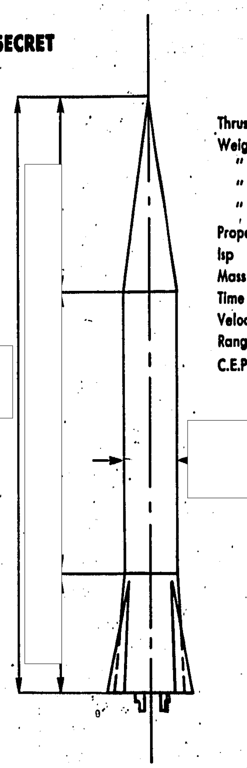
UAR CONQUEROR (AL QAHIR) MISSILE

JULY 1962



JULY 1963, 1964



CHARACTERISTICS

Thrust (sea level)	44,000 lbs.
Weight (gross)	18,400
" (nosecone)	2,000 lbs.
" (structure)	4,000 lbs.
" (propellant)	12,400 lbs.
Propellant	Nitric acid/turpentine
Isp	231 sec.
Mass Ratio	3.07
Time to burn-out	70 sec.
Velocity at burn-out	6,070 fps.
Range	200 n.m.
C.E.P.	3-5 n.m.

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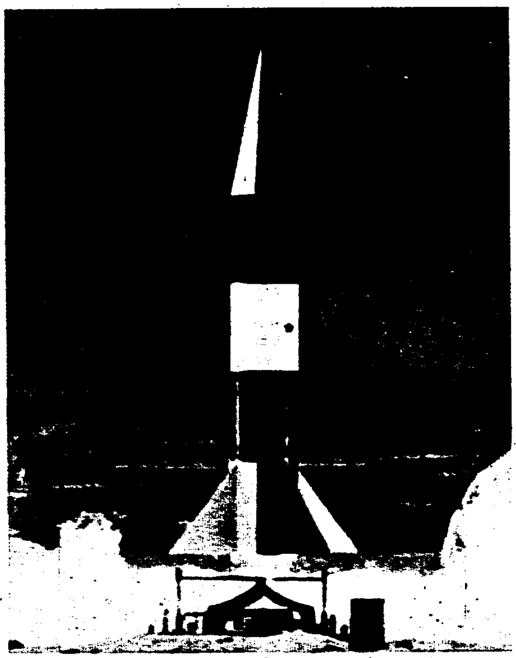

UAR CONQUEROR (AL QAHIR) MISSILE

21 July 1962

Figure 6

man V–2. Similarly, where previously the Conquerors were transported simply on flat-bed trailers, two of those shown in the 1963 and 1964 parades were carried on trailers fitted with erecting-launching rails and jack-stabilized firing rings. (See figure 5.)

Initially, both missiles were unguided. However, a pre-set guidance system was added, and reportedly has produced CEP's on the order of 3 to 5 nautical miles. The Egyptians are now attempting to develop an all-inertial system with a CEP of less than 2 nautical miles, but admit that the system will not be operational before 1967 at the earliest. To [redacted]

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probably with orders to develop such a system. Recent flight tests, probably of this new system, revealed serious vibrations in the missiles. It was reported that the missiles were going out of control when they reached the speed of sound because "the guidance system was incapable of overriding the vibrations set up in the rudders."[10] This problem appears to reflect rather serious design faults in the missiles and their new guidance systems. Further flight testing has been suspended until the difficulties are overcome.

The program has been plagued by technical, personnel, and financial difficulties almost since it began. For example, Brigadier Khalil reportedly was warned that after July 1965 there might not be any funds available to meet the requirements of the [redacted] The Egyptians, however, undoubtedly are aware of [redacted] 25X6

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Space Program

The Civilian Division in Heliopolis is reportedly working mainly on a space rocket project, the objective of which is to place a 20 to 30 kilogram (44 to 66 pounds) payload in orbit at an altitude of between 450 and 500 kilometers (247 and 270 nautical miles).[8, 15] Little is known of the progress on this project, but Cairo newspapers have repeatedly announced imminent UAR plans to launch first a two-stage high-altitude space probe, and then the three-stage satellite vehicle. A flurry of such press releases in June 1964 announced that the UAR would launch its first earth satellite and was planning other "surprises in the space field" for the annual 23 July independence celebrations.[4] However, on 19 July, Brigadier Khalil announced that all such plans had been postponed indefinitely, explaining that there were still basic problems with the gyro element of the guidance system.[17] This was the fourth such postponement in a year's time.

Figure 7

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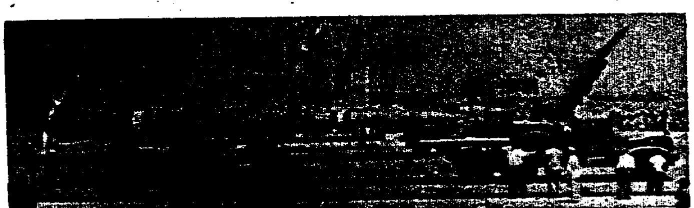
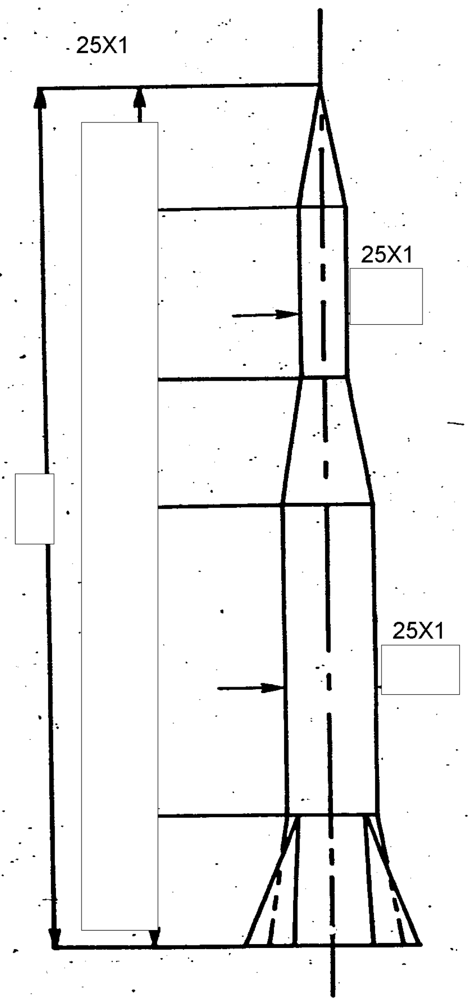
UAR PIONEER (AL RA'ID) MISSILE

UAR Pioneer (Al Ra'id) Two-Stage Missile, July 1963



July 1964



CHARACTERISTICS

2nd STAGE (VICTOR)

Thrust (sea level)	9,000 lbs.
Weight (gross)	3,010 lbs.
" (nosecone)	500 lbs.
" (structure)	710 lbs.
" (propellant)	1,800 lbs.
Propellant	Nitric acid/ turpentine
Isp (at altitude)	250 sec.
Mass Ratio	2.49
Time to burn-out	40 sec.
Velocity at burn-out	11,310 fps.

1st STAGE (CONQUEROR)

Thrust (sea level)	44,000 lbs
Weight (gross)	19,410 lbs.
" (payload)	3,010 lbs.
" (structure)	4,000 lbs.
" (propellant)	12,400 lbs.
Propellant	Nitric acid/ turpentine
Isp	231 sec.
Mass Ratio	2.76
Time to burn-out	70 sec.
Velocity at burn-out	5,290 fps.
Range (approx.)	800 n.m.

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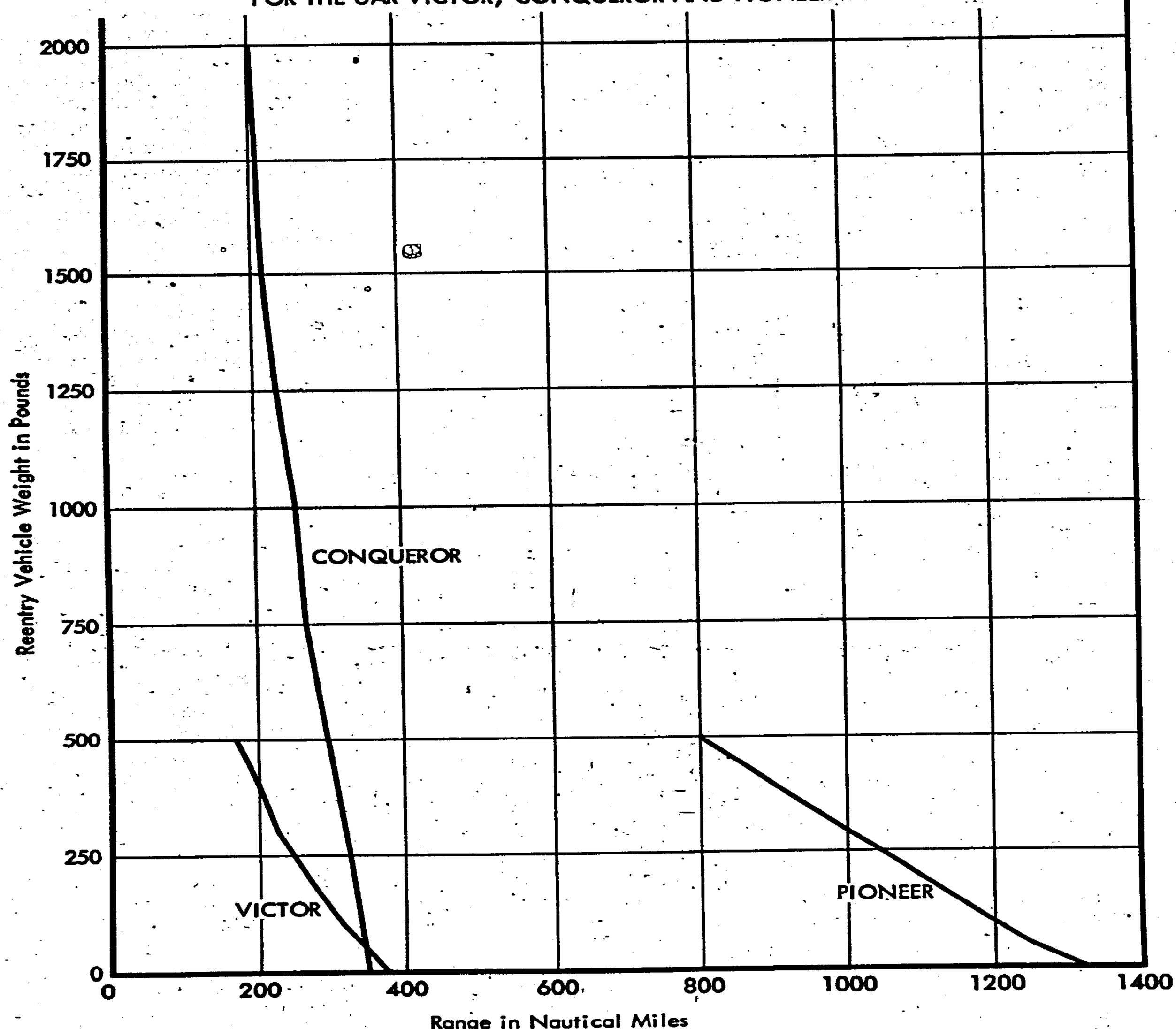
Figure 8

RANGE vs PAYLOAD CURVES
FOR THE UAR VICTOR, CONQUEROR AND PIONEER MISSILES



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Although various reasons (guidance problems, no military significance, insufficient testing, bad weather) have been given for these postponements, the satellite launch attempt appears to hinge on the development of two items: a first stage booster with sufficient thrust to allow the satellite vehicle to attain orbital velocity (25,000 fps), and a reliable guidance system.[8 18 19] There is a complete void of information on the satellite launch vehicle development program, except for a statement by Pilz that one is "under study," and, by Khalil himself that, "all three stages of the launch vehicle have been static fired."[11 20] There have been numerous reports of guidance difficulties, and several new [redacted] teams were reportedly contracted to develop a workable inertial system.[17] At the same time, the Egyptians are generally casting about for an easily-installed "package" system.

The Egyptians are determined to attempt a satellite launch.[18] However, attempting and succeeding are two different matters; calculations indicate that none of the combinations of hardware available to them are capable of attaining injection velocity. (The maximum velocity attainable by any conceivable UAR launch vehicle falls at least 5,000 fps short of the minimum required orbital velocity of 25,000 fps.)

Fuel Conversion Efforts

The Egyptians are apparently trying to improve the capabilities of their missiles by changing fuels. Presently, all missiles utilize a fuel combination of turpentine and nitric acid, both reportedly produced right in Heliopolis.[21] However, recent information indicates that a change to a hydrazine/nitric acid mixture is being attempted.[22-24] The hydrazine mixture has a specific impulse (I_{sp}) of approximately 250 seconds and a density of 1.26 grams per cubic centimeter. Compared to the I_{sp} of 231 seconds and the density of 1.36 grams per cubic centimeter of the old turpentine mixture, the fuel change would boost range and payload-carrying capacity about 10 percent.

[redacted]

TEST AND SUPPORT AREAS

The launch and test installation from which all known UAR missile flight testing has been done is located about 27 nautical miles west-northwest of Cairo. (See figure 9.) The site is located about 14 nautical miles west-southwest of the abandoned Gebel Hamzi (alt: Jabal Hamzi) Airfield, which lies along the desert road between Cairo and Alexandria. Served from the desert road by a secondary road, the launch facility consists of several static test stands and mobile launch systems, two missile assembly hangars, a rather large administration building, two blockhouses, six or seven explosion-proof buildings and several other small support facilities. No other launch positions, impact areas, or downrange instrumentation sites have been reported.[13]

Several early small sounding rocket firings reportedly took place to the south of Cairo, probably from an old artillery range and surface-to-air missile training area at Dashur, but there has been no SSM-associated activity there.

Missile component development, as well as fuel production, takes place in Heliopolis, an eastern suburb of Cairo, principally at a factory designated No. 333. This is where [redacted] and appears to be the key plant in the missile program. (See figure 10.) Final assembly of the missiles is accomplished right at the range.[14]

Figure 9

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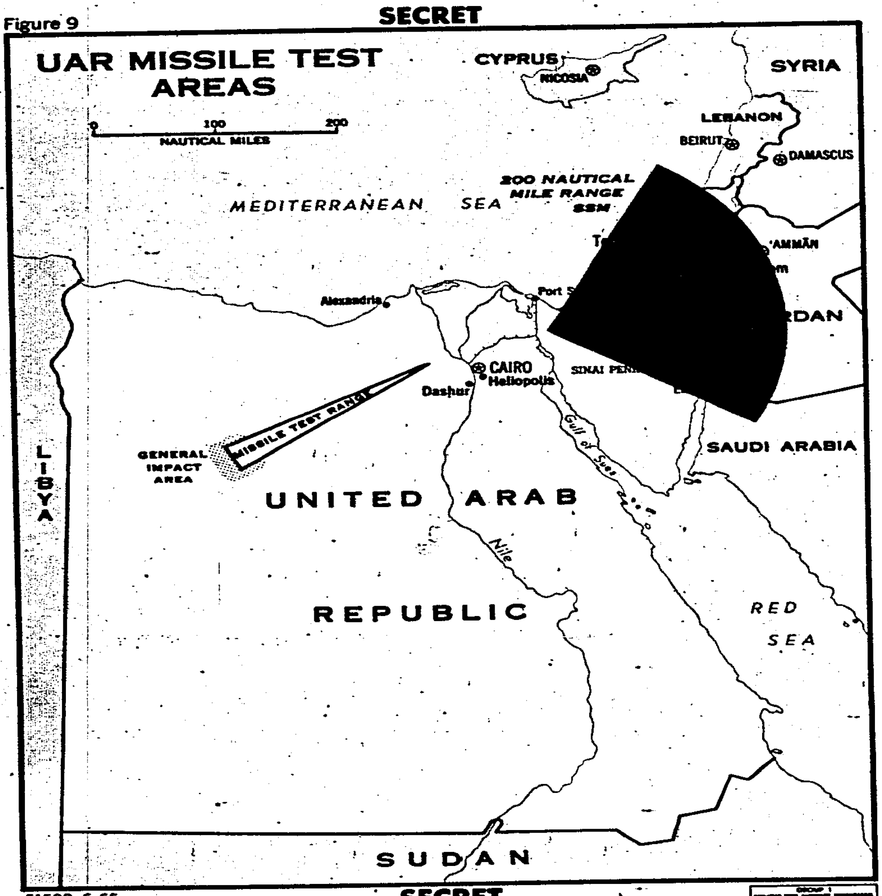

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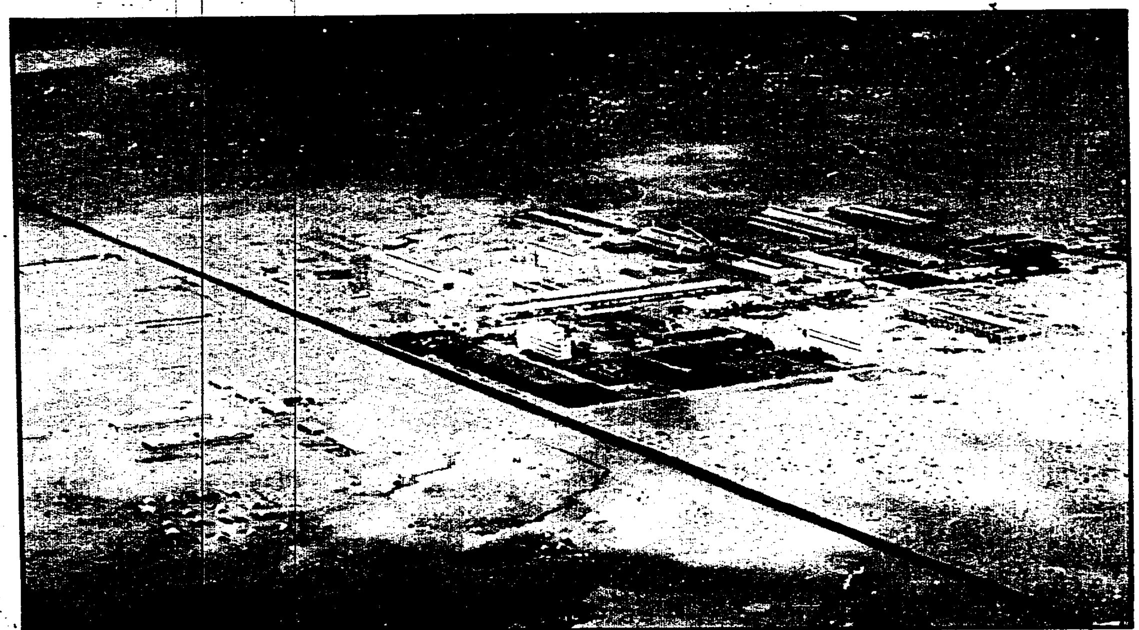
There have been several vague indications that a second SSM launch site exists somewhere in the Eastern Desert; one report locates it 120 kilometers (64 nautical miles) east of Cairo along the Cairo-Suez road.[8 9 27] Although it is still unconfirmed, such a location would seem a logical second site for two reasons. First, it would serve as a good satellite launch site in that the launch could be made in an easterly direction (to gain the added velocity of the earth's rotation) without having to pass over any heavily-populated areas. Also, such an Eastern Desert site would bring Tel Aviv and all of Israel within range of any of the UAR surface-to-surface missiles. (See figure 9.)



UAR Military Factory 333, Heliopolis, Egypt, September 1964

Figure 10

APPENDIX A

UAR MISSILE PERFORMANCE CALCULATIONS

The Victor

T = thrust at launch = 9,000 lbs.

W_o = gross weight at launch = 3,310 lbs.

W_{bo} = weight at burnout = 1,210 lbs.

MR = mass ratio $= \frac{W_o}{W_{bo}}$ = 2.74

t = burning time = 50 secs.

I_{sp} (turpentine/nitric acid) = 231 secs.

Velocity at Burnout:

$$V_{bo} = I_{sp} \cdot g \cdot \ln MR - g \cdot t \left[\frac{D}{W} + \sin\theta\right]$$

$$\text{(assuming } \left[\frac{D}{W} + \sin\theta\right] = 1\text{)}$$

$$'' = 231(32.2)(\ln 2.74) - 32.2(50)$$

$$'' = 231(32.2)(1.01) - 32.2(50)$$

$$'' = 7500 - 1610 \qquad = \underline{5{,}890 \text{ fps.}}$$

Range:

$$R = \frac{(V_{bo})^2}{g(6{,}080)} = \frac{(5{,}890)^2}{32.2(6{,}080)} \qquad \doteq \underline{175 \text{ n.m.}}$$

The Conqueror

T = thrust at launch = 44,000 lbs.

W_o = gross weight at launch = 18,400 lbs.

W_{bo} = weight at burnout = 6,000 lbs.

MR = mass ratio $= \frac{W_o}{W_{bo}}$ = 3.07

t = burning time = 70 secs.

I_{sp} (turpentine/nitric acid) = 231 secs.

Velocity at Burnout:

$$V_{bo} = I_{sp} \cdot g \cdot \ln MR - g \cdot t \left[\frac{D}{W} + \sin \theta\right]$$

$$\text{(assuming } \left[\frac{D}{W} + \sin \theta\right] = 1\text{)}$$

$$\text{"} = 231(32.2)(\ln 3.07) - 32.2(70)$$

$$\text{"} = 231(32.2)(1.12) - 32.2(70)$$

$$\text{"} = 8{,}330 - 2{,}260 = \underline{6{,}070 \text{ fps.}}$$

Range:

$$R = \frac{(V_{bo})^2}{g(6{,}080)} = \frac{(6{,}070)^2}{32.2(6{,}080)} \cong \underline{200 \text{ n.m.}}$$

The Pioneer

		1st Stage	2nd Stage
T	= thrust	= 44,000 lbs.	9,000 lbs.
W_o	= gross weight	= 19,410 lbs.	3,010 lbs.
W_{bo}	= weight at burnout	= 7,010 lbs.	1,210 lbs.
MR	= mass ratio $= \frac{W_o}{W_{bo}}$	= 2.76	2.49
t	= burning time	= 70 secs.	40 secs.
I_{sp}	= (turpentine/nitric acid)	= 231 secs.	250 secs.

Velocity at 1st Stage Burnout:

$$V_1 = I_{sp} \cdot g \cdot \ln MR - g \cdot t \left[\frac{D}{W} + \sin\theta\right]$$

$$\left(\text{assuming} \left[\frac{D}{W} + \sin\theta\right] = 1\right)$$

$$'' = 231(32.2)(\ln 2.76) - 32.2(70)$$

$$'' = 231(32.2)(1.015) - 32.2(70)$$

$$'' = 7{,}550 - 2{,}260 \qquad = \underline{5{,}290 \text{ fps.}}$$

2nd Stage Velocity Increment:

$$V_2 = 250(32.0)(\ln 2.49) - 32.0(40)$$

$$'' = 250(32.0)(.913) - 32.0(40)$$

$$'' = 7{,}300 - 1{,}280 \qquad = \underline{6{,}020 \text{ fps.}}$$

Total Velocity at 2nd Stage Burnout:

$V_{bo} = V_1 + V_2$ $= \underline{11{,}310 \text{ fps.}}$

Range:

$$R = 2\, R_c \text{ arc tan} \left[\frac{V_{bo}^2 \sin \theta_c \cos \theta_c}{R_c g_c - V_{bo}^2 \sin^2 \theta_c} \right]$$

where:

R_c = radius from earth's center to cutoff altitude $= 21.9(10^6)$ ft.

g_c = apparent gravity at cutoff altitude (~ 200 mi.) $= 29.1$ fps.^{2}

θ_c = burnout path angle $= 45°$

R $\doteqdot \underline{800 \text{ n.m.}}$

As a Vertical Sounding Rocket:

1st Stage Burnout Altitude: $\doteqdot \underline{147{,}000 \text{ ft.}}$

2nd Stage Burnout Altitude: $\doteqdot \underline{455{,}600 \text{ ft.}}$

Maximum Altitude:

$\doteqdot 2.5(10^6)$ ft. $\doteqdot \underline{400 \text{ n.m.}}$

25X6

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